

CLAIMS

What is claimed is:

1. A powder deposition apparatus operable to form a deposit on a deposition substrate, the powder deposition apparatus comprising:
 - a deposition gun comprising
 - a combustion chamber wherein a mixture of a fuel and an oxidizer
 - 5 is burned to generate a pressurized deposition gas flow,
 - a mixer wherein the pressurized deposition gas flow is mixed with a powder flow to form a deposition mixture flow,
 - a deposition flow director that receives the deposition mixture flow from the mixer and directs the deposition mixture flow toward the deposition
 - 10 substrate, and
 - a cooling structure operable with a flowing coolant passing therethrough and in cooling communication with the mixer and with the deposition flow director;
 - an instrumentation array providing
 - 15 a fuel measurement of a flow rate of the fuel to the combustion chamber,
 - an oxidizer measurement of a flow rate of the oxidizer to the combustion chamber,
 - a powder measurement of a flow rate of a powder feed to the mixer,
 - 20 and
 - a coolant measurement of a cooling capacity of the coolant; and
 - a deposition controller including
 - a controllable fuel source of the fuel communicating with the combustion chamber, wherein the controllable fuel source is automatically
 - 25 controlled responsive to the fuel measurement,
 - a controllable oxidizer source of the oxidizer communicating with the combustion chamber, wherein the controllable oxidizer source is automatically controlled responsive to the oxidizer measurement,

30 a controllable powder source of the powder flow communicating with the mixer, wherein the controllable powder source is automatically controlled responsive to the powder measurement, and

a controllable coolant source of a flow of the coolant that provides an inlet flow of coolant to the cooling structure, wherein the controllable coolant source is automatically controlled responsive to the coolant measurement.

2. The powder deposition apparatus of claim 1, wherein the mixer comprises

a central powder flow injector, and

5 a set of deposition gas injectors arranged around a periphery of the central powder flow injector.

3. The powder deposition apparatus of claim 1, wherein the deposition flow director includes

a barrel that receives the deposition mixture flow from the mixer, wherein the mixer is positioned at a first end of the barrel, and

5 a powder spray nozzle positioned at a second end of the barrel opposite from the first end, wherein the powder spray nozzle is operable to project the deposition flow mixture toward the substrate.

4. The powder deposition apparatus of claim 1, wherein the cooling structure comprises

a cooling jacket extending around at least a portion of the mixer and the deposition flow director.

5. The powder deposition apparatus of claim 1, wherein the controllable fuel source comprises a source of hydrogen gas, and the controllable oxidizer source comprises a source of oxygen gas.

6. The powder deposition apparatus of claim 5, wherein a flow ratio of the hydrogen gas to the oxygen gas is from about 2.2 to about 2.6.

7. The powder deposition apparatus of claim 1, wherein the controllable powder source comprises a source of a mixture of the powder entrained in a carrier gas.

8. The powder deposition apparatus of claim 1, wherein the coolant measurement comprises a measured temperature of the flowing coolant, and wherein the controllable coolant source comprises

5 a heat exchanger that receives an outlet flow of the coolant, controllably cools the outlet flow of the coolant responsive to the measured temperature, and provides a cooled coolant flow to the cooling structure.

9. The powder deposition apparatus of claim 1, wherein the coolant measurement comprises a measured outlet temperature of an outlet flow of the coolant from the cooling structure, and wherein the controllable coolant source comprises

5 a heat exchanger that receives an outlet flow of the coolant, controllably cools the outlet flow of the coolant responsive to the measured outlet temperature, and provides a cooled coolant flow to the cooling structure.

10. The powder deposition apparatus of claim 1, wherein the coolant measurement comprises a measured flow rate of the coolant, and

5 wherein the controllable coolant source comprises a flow controller that provides the flow of the coolant responsive to the measured flow rate of the coolant.

11. The powder deposition apparatus of claim 1, further including a robotic head that supports and moves the deposition gun.

12. A method for forming a deposit on a deposition substrate, comprising the steps of

providing a deposition gun that burns a mixture of a fuel and an oxidizer to form a deposition gas flow, mixes a powder into the deposition gas flow to
5 form a deposition mixture flow, and projects the deposition mixture flow therefrom, wherein the deposition gun is provided with a flowing coolant;

measuring a flow rate of the fuel to the deposition gun, a flow rate of the oxidizer to the deposition gun, a flow rate of the powder to the deposition gun, and a cooling capacity of the coolant flow; and

10 set-point controlling the flow rate of the fuel, the flow rate of the oxidizer, the flow rate of the powder, and the cooling capacity of the coolant flow, all responsive to the step of measuring.

13. The method of claim 12, wherein the step of measuring comprises a step of

measuring a coolant temperature of the coolant flow.

14. The method of claim 12, wherein the step of measuring comprises a step of

measuring a coolant flow rate of the coolant flow.